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ABSTRACT

During each of two school quarters, approximately 60 college students enrolled in a mathematics course were randomly assigned to an experimental group or a control group. The control group received instruction by the lecture method only; the experimental group received the same instruction, except that six computer-assisted instruction (CAI) units were substituted for six class lectures. All students were given a pretest and a posttest measuring attitude toward CAI, attitude toward mathematics, and achievement in the mathematical content of the CAI units. The following conclusions were drawn: (1) The experimental group's attitude toward CAI improved significantly from pretest to posttest, but the control group's attitude toward CAI did not change significantly; (2) attitudes toward mathematics improved in both the experimental group and the control group; (3) both the experimental group and the control group showed significant achievement gains, and there was no significant difference between the achievement of the two groups. (Author)

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CAI: Overcoming Attitude Barriers

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ABSTRACT

During each of two school quarters, approximately 60 college students enrolled in a mathematics course were randomly assigned to an experimental group or a control group. The control group received instruction by the lecture method only; the experimental group received the same instruction, except that six computer-assisted instruction (CAI) units were substituted for six class lectures. All students were given a pre-test and a post-test measuring attitude toward CAI, attitude toward mathematics, and achievement in the mathematical content of the CAI units. The following conclusions were drawn: 1) The experimental group's attitude toward CAI improved significantly from pre-test to post-test, but the control group's attitude toward CAI did not change significantly. 2) Attitudes toward mathematics improved in both the experimental group and the control group, but this change reached significance level only in the control group. 3) Both the experimental group and the control group showed significant achievement gains, and there was no significant difference between the achievement of the two groups.

INTRODUCTION

Although many studies have compared the achievement of students using computer-assisted instruction (CAI) with the achievement of students using more traditional methods of instruction, relatively few studies have made more than a token attempt to assess the attitudes of students using CAI. Separate studies by Mathis et al (4) and by Sherman and Klare (6) each found that attitudes toward CAI improved significantly in students who had a single exposure to CAI, but neither researcher assessed the effects of repeated CAI usage. In a more extensive study involving an average of 19 hours of CAI for each student, Hall (3) found that students' attitudes toward CAI were favorable. Brown and Gilman (2) also report relatively favorable attitudes toward CAI as measured by a forty-item Likert style questionnaire. Since the studies by Hall (3) and by Brown and Gilman (2) assessed attitude on a post-test only basis, however, they provide no

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information on attitude changes through the use of CAI. One can ask of all of these studies exactly what form of CAI was used. Some CAI is sophisticated with the use of cathode say tube displays and audio messages such as in the PLATO system. Other CAI is comprised of simply a computer connected typewriter with hand copy print out. But no matter what the form of the CAI the educator should be concerned with the underlying student attitude and attitude change.

This investigation began with the idea that attitudes are important; that a method of instruction ought to be judged not only on the amount of information the student has digested or the skills he has gained, but on the student's attitudes as well. In particular, the attitudes of prospective primary teachers toward CAI (computer connected typewriter with hand copy print out) would be of special interest, since these students may have the opportunity to use the computer within their own classrooms at some time in their career. Assuming then, that a student's achievement, attitude toward CAI, and attitude toward the subject he is studying are relevant variables, it is reasonable to ask whether the use of CAI as a part of a student's academic work will significantly change any of these variables. Thus the central objectives of the study were as follows:

1. To develop six CAI units. Each unit is an automated programmed instruction lesson that covers a topic normally included in Math 190, a course designed primarily for elementary education majors, at Iowa State University. The units were written in CPS (Conversational Programming System), and each unit provides approximately 30 minutes of instruction For the experimental group (the CAI group), these six units were used as a replacement for six traditional classroom lectures covering the same topics.

2. To determine if the use of CAI as a part of an undergraduate mathematics course can change the student's attitude toward mathematics.

3. To determine if the use of CAI as a part of an undergraduate mathematics course can change the student's attitude toward this form of CAI.

4. To compare gains of knowledge of mathematics made by CAI students with gains made by students in a conventional lecture situation (the control group).

METHODS

The experiment was conducted in two parts; the first trial, which was used to evaluate and improve the computer programs and the testing instruments, and the replication, which was conducted approximately six months later.

Two hundred forty-three students enrolled in Math 190 in winter quarter, 1972, took the pre-tests in attitude toward CAI, attitude toward math, and achievement in mathematics during the frist class period of the quarter. By using a table of random numbers, a stratified random sample was drawn to form an experimental group and a control group. Each group consisted of 16 elementary education majors and 16 students not majoring in elementary education.

Students in the experimental group were told that on six specified class days during the quarter they were not to attend class. Instead, they were required to use the CAI unit (computer connected typewriter with hard copy print out) covering the same topic as that day's class lecture. Students were required to turn in the IBM sheet from the typewriter terminal after each lesson, but they were given assurance that the quality of their performance on the computer would have no effect on their course grade.

As a result of the first trial, one CAI unit was replaced by a new unit dealing with a different topic, and minor changes were made in the remaining five units and in the CAI attitudinal questionnaire. Except for these changes, however, the experimental procedure used during the first trial was repeated the following fall quarter, using an experimental group of 30 students (21 in elementary education and 9 not majoring in elementary education), and a control group of 30 students (21 majoring in elementary education, and 9 not majoring in elementary education). By means of a stratified random sample, these students were selected from 135 students enrolled in Math 190.

The questionnaire used for the experimental group as a post-test measure of attitude toward CAI is a modified version of a 40-item questionnaire developed by Brown at Pennsylvania State University (5). By changing the wording of this questionnaire, a second form, suitable for students who had not experienced CAI, was developed. This second form was used as a pre-test for all students and as a post-test for students in the control group. A scale developed by Aiken and Dreger (1) was selected as a pre-test and a post-test in attitude toward mathematics. The achievement measures used as a pre-test and a post-test of mathematics achievement were constructed by the investigators.

RESULTS

Attitudes toward CAI: The experimental group's attitude toward CAI improved significantly in the first trial ($_{27}t=7.19, p<.01$) and in the replication ($_{25}t=6.97, p<.01$), but the control group's attitude toward CAI did not change significantly in either trial of the experiment. Furthermore, an analysis of covariance using two classifications for the treatment (CAI or traditional instruction) and two classifications for curriculum (elementary education or not elementary education), and using the pre-test attitude toward CAI as the covariate revealed significant differences between the treatments

in the first trial ($_{1,53}F=27.89, p<.01$) and in the replication ($_{1,48}F=42.13$, $p<.10$). That is, in both trials, the experimental group and the control group held significantly different attitudes toward CAI at the end of the experiment. The F values associated with the interaction between treatment and curriculum were not significant in either trial.

Attitudes toward mathematics: T he experimental group's attitudes toward mathematics improved, but did not improve significantly, in both trials of the experiment. The control group's attitude toward mathematics, though, improved significantly in the first trial ($_{29}t=2.10, p<.05$) and in the replication ($_{26}t=3.30, p<.01$). However an analysis of covariance using pre-test math attitude scores as a covariate showed no significant differences between treatments in either the first trial or the replication. Again, the effects of curriculum and of interaction between treatment and curriculum were not significant at the .05 level in either trial of the experiment.

Achievement in mathematics: In the first trial, significant achievement gains were made by students in the CAI group ($_{27}t=13.57, p<.01$) and in the control group ($_{29}t=7.38, p<.01$). Similarly, both the CAI group ($_{25}t=15.49, p<.01$) and the control group ($_{26}t=15.46, p$ .01) showed significant gains in math achievement in the replication. Also, in each trial of the experiment, the analysis of covariance using the pre-test math scores as the covariate revealed no significant differences between treatments, no significant differences between curricula, and no significant interaction between treatment and curriculum. Means and standard deviation for the major variables for each trial are shown in Tables 1 and 2.

Table 1 - Means and standard deviation of the major variables in the study: first trial data*

Variable	CAI group mean	CAI group standard deviation	Control group mean	Control group standard deviation
Pre-test CAI attitude	90.04	11.86	87.53	13.18
Post-test CAI attitude	107.68	10.92	91.03	14.23
Pre-test math attitude	59.32	19.76	50.03	20.90
Post-test math attitude	61.75	17.82	53.47	19.01
Pre-test math achievement	8.36	3.58	7.77	2.85
Post-test math achievement	16.64	3.76	15.07	5.30

*On the CAI measure, a theoretically neutral score is 87, while possible extreme scores are 29, expressing a negative attitude toward CAI, and 145, expressing a positive attitude toward CAI. On the math attitude, a theoretically neutral score is 60, but the most negative score possible is 20, and the most positive socre possible is 100. Possible extreme scores on the math achievement measure are 0 and 24.

Table 2 - Means and standard deviations of the major variables in the study: replication data**

Variable	CAI group mean	CAI group standard deviation	Control group mean	Control group standard deviation
Pre-test CAI attitude	74.46	13.91	76.07	13.04
Post-test CAI attitude	94.88	9.95	78.44	10.26
Pre-test math attitude	62.19	18.53	61.26	17.05
Post-test math attitude	65.27	16.51	68.78	15.68
Pre-test math achievement	7.35	2.48	7.00	2.39
Post-test math achievement	16.88	2.88	17.22	3.14

** Between the first trial and the replication, an item analysis was done on the CAI attitude questionnaire and four questions were thus eliminated. Hence, a theoretically neutral score on the CAI measure used in the replication is 75, and possible extremes are 25 and 125. The other measures are as described in the previous table.

DISCUSSION

Realizing that there are many other factors which may have contributed to the positive attitude shift of the involved students toward CAI in this experiment and realizing that it is very difficult to control or eliminate all extranenous variables influencing attitude, under the constraints as established in this experiment it appears as though a student's attitude toward CAI can be changed through the use of CAI as part of his course work. In both trials of the experiment, attitudes toward CAI improved significantly in students who used CAI, but failed to improve significantly, for the students in the control groups. Nevertheless, in both the first trial and the replication, an analysis of covariance controlling on pre-test attitudes toward mathematics scores revealed that the attitudes toward mathematics of the two groups were not significantly different. It would seem, then, that there is not enough evidence to say that CAI is less effective than traditional instruction in changing attitudes toward mathematics, but the hope that CAI would lead to a greater attitude gain toward mathematics was definitely not substantiated.

This experiment also provided no significant difference in mathematics achievement between students who had used CAI and students who recieved traditional instruction, and no significant differences were revealed by the analysis of covariance. In assessing achievement, however, it should be noted that a typical student would complete each CAI unit in less time than the standard 50 minute class period. Thus CAI may be credited with producing achievement gains comparable to those resulting from traditional instruction in less time than was required by traditional instruction.

Recommendations for the classroom include the following:

1. The use of CAI as a part of a student's academic program does appear to be an effective means of improving his attitude toward CAI. In situations in which such improvement is an objective, this "hands-on" approach should definitely be considered.

2. Although students' attitudes toward mathematics did improve somewhat, these attitudes are still not very favorable, especially in the students participating in the first trial of the experiment. Attempts should be made to find ways of improving these student attitudes.

3. Computer-assisted instruction does appear to be a viable instructional strategy. Instructors should consider using CAI when it is appropriate for their educational objectives

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